MANAGEMENT OF IMPACTED URETERIC CALCULUS USING URETEROSCOPY AND PNEUMATIC LITHOTRIPSY – A PROSPECTIVE STUDY

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CERTIFICATE

This is to certify that this dissertation entitled 'MANAGEMENT OF IMPACTED URETERIC CALCULUS USING URETEROSCOPY AND PNEUMATIC LITHOTRIPSY - A PROSPECTIVE STUDY' submitted by Dr.JAYAMURUGAN.B, appearing for M.Ch (Urology) degree examination in August 2007 is a bonafide record of work done by him under my direct guidance and supervision in partial fulfillment of requirements of the Tamil Nadu Dr. M.G.R Medical University, Chennai. I forward this to the Tamil Nadu Dr. M.G.R Medical University, Chennai, Tamil Nadu, India.

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CONTENTS

Introduction

Urologists have always been at the forefront of minimally invasive surgery, though for the most of 20^{th} century, these procedures were confined to the lower urinary tract. Over the last two decades, introduction of ureteroscopic and percutaneous techniques has extended our minimally invasive approach to upper urinary tracts as well. This technology allows urologists to take their endoscopic expertise as high as pyelocalyceal system, not just for the stone disease, but for a myriad of benign and malignant process.

Management of ureteric stones has undergone a drastic change with the advent of various minimally invasive treatment modalities since the early 1980s. Miniaturization of rigid, semi rigid and flexible ureteroscopes, availability of ESWL, as well as further advancement of urological laparoscopic surgery, has almost eliminated open stone surgery in favor of minimally invasive stone removal techniques. Retrograde ureteroscopy for treatment of ureteric calculi continues to be a sought after modality as it is both patient and surgeon friendly. The success rate of retrograde ureteroscopy has gradually improved over the years. The reasons are better understanding of endoscopic anatomy of Ureter and kidney, availability of refined and state-of-the-art ureteroscopes along with an array of useful gadgets, more effective methods of intraureteral lithotripsy and better recognition and management of complications. In case of distal ureteral calculi there is hardly any doubt that retrograde ureteroscopy has a definite edge over ESWL as it is more efficacious. But when it comes to proximal ureteric calculi the indications for ureteroscopy are less well defined. A debate is still going on as to which is better for managing proximal ureteral calculi.

Impacted stones in the Ureter are difficult to treat as compared to non impacted stones. Impacted stones are those which tend to stay at the same site over a long period of time. The success rate of ESWL is reported to be quite low in such cases and role of ureteroscopic approach is still being challenged for impacted ureteric calculi. In addition, although new lithotripsy instruments such as laser have been developed, the question of optimal treatment for impacted ureteric calculi remains controversial. In the present study, we did a prospective evaluation of the effectiveness of ureteroscopic pneumatic lithotripsy for impacted ureteric calculi.

AIMS AND OBJECTIVES

1.To assess the outcome of ureteroscopy and pneumatic lithotripsy for impacted ureteric calculus

2.To analyse the factors influencing success of ureteroscopy and pneumatic lithotripsy for impacted ureteric calculus .

3.To evaluate the immediate complications of ureteroscopy for impacted ureteric calculus.

REVIEW OF LITERATURE

ENDOSCOPIC ANATOMY OF URETER

The Ureter, a narrow cylindrical muscular tube in the retroperitoneal space, extends from the UPJ above to the ureteral orifice in the bladder below. In the adults its length varies from 24 to 30cm, although it may occasionally be shorter or longer. Under physiological conditions its lumen is approximately 3 mm wide, and endothelial lining in a non-distended ureter is folded into six folds. With distension, these folds efface and therefore are not seen at ureteroscopy. The Ureter is normally constricted at its origin from the UPJ, at the level of pelvic brim where it is crossed by iliac vessels and at ureterovesical junction where its lumen is narrowest.

Traditionally the ureter has been divided into thirds: an upper third from UPJ to superior margin of sacroiliac joint, middle third from superior margin of sacroiliac joint to its inferior margin and lower third from inferior margin of sacrum to ureterovesical junction. The three-part division was consistent with different open surgical approaches used for ureteric calculi. However with the advent of minimally invasive techniques, open surgery is rarely used, and the ureter is divided into only two segments: proximal and distal with the point of division being the site of cross over of ureter over the iliac vessels.

The abdominal (upper) ureter lies posterior to the peritoneum over psoas major muscle, which separates it from the tips of the transverse processes of lumbar vertebrae. Gonadal vessels, usually at the level of third lumbar vertebra, cross the upper ureter. During endoscopy, the upper ureter is seen as relatively straight lumen, unless, underlying pathology or an anatomic kink dictates otherwise.

The pelvic (lower) ureter extends from the pelvic brim to its termination. It is as long as its abdominal counterpart. It descends posterolaterally close to lateral wall of pelvis. At the level of ischial spine, it turns anteromedially to reach base of urinary bladder.

The intramural ureter, approximately 1.5.to 2.5 cm in length, courses obliquely and medially within the bladder and terminates as the ureteric orifice at the lateral end of interureteric bar. Each orifice forms an oblique slit, facing medially, with distinguishable medial and lateral lips.

The distance between two orifices is approximately 5 cm in a full bladder and decreases with emptying. The shape and orientation of ureteric orifices may vary considerably. These variations may compromise ease of access during ureteroscopy.

The entire ureter is lined by transitional cell epithelium. Beneath it lays a layer of connective tissue, the lamina propria, which together with the epithelium forms mucosa. Deep to this is a layer of smooth muscle, which can be differentiated into an inner layer of longitudinal fibers and an outer layer of circular muscle bundles. Outermost is a thin layer of adventitia, which contains longitudinally running plexus of ureteral blood vessels and lymphatics. The muscular and adventitial layers are thicker in distal ureter, compared to its proximal counterpart. It is because of this reason the complications such as perforation and avulsion are more common in proximal ureter.

DEVELOPMENT OF URETEROSCOPES

Cooperation between urologists active in this field and endoscope manufacturers has led to improvement in various ureteroscope designs. Each ureteroscope design has different advantages and disadvantages. Knowledge of these allows the urologist to select the best tool for each endoscopic task.
The first ureteroscopic procedure was done by Hugh Hampton Young in 1912 and reported in 1929[1]. This was done during cystoscopy of a 2-month-old child with massively dilated ureters caused by posterior uretheral valves. Because of ureteral dilatation, he was able to advance 9.5 F pediatric cystoscope to the level of pelvis, visualizing calyces.

Advances in fiber optics led to the development of flexible ureteroscopes before routine rigid ureteroscopy. Marshal[2] first reported experience with flexible ureteroscopes in 1964 and later by Takagi[3] et al and Bush[4] et al. These early ureteroscopes did not achieve wide acceptance because of the limited working capability.

It was not until 1977 that rigid ureteroscopy was reported independently by Goodman[5] and Lyon[6]. An 11 F pediatric cystoscope was used by Goodman to visualize distal ureter in three adults. Lyon et al reported use of Jwett sounds for ureteral dilatation permitting ureteroscopy in five adults using 11 F pediatric cystoscope. These early investigators showed the safety of ureteroscopy.

The actual development of small diameter rigid ureteroscope was made possible by the work of Harolds Hopkins[7]. He developed a rod lens system in 1960, revolutionizing endoscope design. Hopkins rod lens system replaced air spaces in the old design with glass rods. Smaller outer diameter endoscopes could be developed more easily now, to be used as ureteroscopes.

The first endoscope specifically designed for ureteroscopy was made by Richard Wolf Medical Instruments. Its use reported in 1979 by Lyon[8] et al. it was modeled after pediatric cystoscope but had a working length of 23 cm. It was available in sizes of 13, 14.5, 16F. Using this ureteroscope, ureteral stones were retrieved for the first time[9]. Perez Castro and Martinez-Piniero[10], working with Karl Storz Endoscopy in 1980, reported the development of a longer (39cm) ureteroscope that could reach the renal pelvis.

Initial ureteroscopes required removal of the scope after basketing the stone and blind placement of ultrasound probe for lithotripsy. Ureteroscopes were then developed with offset eyepiece telescopes. This resulted in straight working channel that allowed passage of ultrasonic probe to break the stone under vision.

Problems with the insertion of larger ureteroscopes made it apparent that smaller ureteroscopes were needed. In 1989 Huffman[11] described a compact uerteroscope in which rod lens telescope was integrated into the ureteroscopic sheath. This helped decrease the outer diameter (8.5F) while maintaining a good-sized working channel.

Later, use of fiber optics allowed much smaller optical system, which also could be bent without distortion of image. The half-moon distortion, which resulted from slight angulation of rod lens telescope, was not encountered when using flexible fiber optic imaging bundle. Dretler and Cho[12] first described this type of ureteroscope in 1989. These semi rigid ureteroscopes are the most popular ureteroscopes today.

Recently there has been a renewed interest in development of flexible ureteroscopes. With advances in technology the flexible ureteroscopes available today are capable of treating proximal ureteric and even intra-renal calculi. Their major drawback is that they are very costly and have very short life.

Management of ureteric calculus

Ureteral calculus is one of the common entities encountered by the practicing urologist. With the introduction of ureteroscopes and ESWL, the management of ureteral calculus has become more minimally invasive than previously, when ureterolithotomy was the only treatment

Pain is the most common presenting feature in patients with ureteric calculus. Prostaglandins are the primary cause for the pain, which also increase ureteric peristalsis aiding in stone passage. [13]

Ureteric calculi of less than 1 week duration and of less bothersome symptoms may be managed expectantly. Infection associated with ureteral calculus is relatively common and may be associated with septicemia and shock. Patients with these symptoms deserve early treatment.[14]

URETERIC CALCULI – NATURAL HISTORY:

The traditional indications for intervention in the management of ureteric calculi have been intolerable/intractable symptoms, obstruction, infection and stones, which are unlikely to pass on their own. Therefore a thorough knowledge of natural history of ureteric stones is required to allow better judgment of when conservative measures (e.g. observation) are indicated. Furthermore, such data help the patient weigh the options and decide whether to wait and endure the symptoms or to go for immediate stone removal.

In the absence of external compression or narrowing, width of the stone is most important measurement affecting stone passage[15] (Ueno et al, 1977).

However, measurement of stone size on x-rays may be slightly misleading. Otens and Sanders[16] (1978) reported that stone size is overestimated in 59% cases, underestimated in 15% and correlated accurately with actual size of stone in 26% of cases.

Ueno and colleagues[15] (1977) reported a series of 520 cases of ureteral stones and showed that, for stones less than 4mm, 4 to 6 mm and larger than 6mm, rates of spontaneous passage were 80%, 59% and 21%, respectively.

Morse and Resnic[17] (1991) showed that rates of spontaneous passage are highly dependent on stone location. Passage rates for proximal, middle and distal ureteral calculi were 22%, 46% and 71% respectively.

A review of literature showed that for stone size smaller than 5 mm in proximal and distal ureter passage rates ranged from 29 to 98% and 71 to 98%. Stones larger than 5 mm had lower passage rates ranging from 10 to 53% for proximal ureter and 25 to 53% for distal ureter. Therefore for stones less than 5 mm conservative management is recommended, whereas for larger stones intervention should be considered.

Two studies describe the method to predict stone passage. Miller and Kane[18] (1999) analyzed 75 patients and concluded that stone passage was highly variable and depended heavily on size, location and side. Stones which were smaller, present in distal ureter, and on the right side were more likely to pass.

Duration of symptoms is the important factor followed by degree of hydronephrosis in the management of ureteric calculus. Hence the impacted stones demand immediate intervention. If significant improvement has not occurred for one month, intervention is usually required. Short of definitive therapy, temporary stenting has been shown to facilitate passage of distal stones once stent is removed[19] (Leventhal et al, 1995).

Vaughan and Gillenwater et al studied patients with ureteric obstruction and found 2 weeks of complete obstruction may not cause irreversible damage, whereas if it persists for more than 6 weeks the incidence of permanent damage increases. Jones found that complete recovery of function requires 3 months[20].

Andren et al evaluated 358 patients and found that the patients with prolonged obstruction had 7% permanent renal impairment even after 18 months[21]. Holm and Neilsen et al studied 143 patients and found that obstruction lasting more than 4 weeks resulted in irreversible renal damage[22].

Impacted ureteral stone is commonly considered as a condition where a stone remains at the same site for more than 2 months[23] or those stones, which do not allow a guide wire to pass beyond during the initial attempts.[24.] They are the most difficult to treat, because there is a severe ureteral inflammation and due to this inflammation there has been reported cases of spontaneous kidney rupture and urine extravasation with urinoma formation.[25, 26]

The best treatment for impacted ureteral stones remains controversial. Both ureteroscopy and SWL are advised in the management of impacted ureteric calculus. But their success rate differs. Ureteral inflammation results in an increased risk of ureteral injury by instruments during endoscopic procedure, though ureteroscopic techniques have a high rate of success. Poor results have been obtained with the treatment of impacted ureteral stones by SWL. Ureteroscopic approach is also not so easy and has a high rate of complications. Ureteral stricture formation is a well-recognized complication of impacted stone disease with rates as high as 5% after any treatment modality employed in early series.

Endoscopic lithotripsy refers to the visualization of a calculus in the urinary tract and the simultaneous application of a form of energy to fragment a stone into either extractable or passable pieces. Endoscopic lithotrites include ultrasonic (US), electrohydraulic (EHL), and mechanical devices, as well as various lasers. These instruments are passed through the working channel of the endoscope to fragment stones into extractable pieces. Baskets and graspers are used during lithotripsy to immobilize stones and remove stone fragments.

Pneumatic mechanical devices, such as the Lithoclast, are small endoscopic jackhammers that work best when passed through a straight endoscopic working channel. With reusable stainless steel probes, the Lithoclast can be used through rigid or semirigid endoscopes. The Lithoclast is an efficient and economical means of fragmenting calculi. The Lithoclast is particularly useful with large stones and hard stones. It commonly is used for large renal stones (percutaneously) and distal ureteral stones (ureteroscopically).

Minor ureteroscopic complications are those that have no long-term deleterious effects and, if treated promptly, cause only minimal or transient postoperative problems. Table 1 lists chronologically 4 studies spanning the 10-year evaluation of ureteroscopic equipment and technique. In the initial series from the Mayo Clinic, large-diameter endoscopes were employed, while in the last series, the smallest-diameter ureterorenoscopes were used, with a noticeable decrease in the complication rates.

Table 1: Minor complications (%)

Author	***Blute***	***Adlel-Razzak***	***Harmon***	***Grasso***
Year Published	1988	1992	1997	1998
Procedures	346	290	209	584
Colic/pain	---	9	3.5	5.5
Fever	6.2	6.9	2	1.4
False passage	0.9	---	---	0.4
Minor hematuria	0.5	2.1	0	0.7
Prolonged hematuria	0.3	1	0	0.2
Extravasation	0.6	1	---	---
Urinary tract infection	---	1	---	1.6
Pyelonephritis	---	---	---	0.5

(27,28,29,30)

In general, the minor complication rate from ureterorenoscopy was decreased based on refined technique, experience of the operators, and prompt treatment or prevention of intraoperative problems. Prophylactic parenteral antibiotics, careful guidewire placement, minimization of excessive ureteral dilation, and postoperative ureteral stenting all have impact on the rate of postoperative problems. This, combined with better surgical training and improved instrumentation, resulted in this very positive trend.

Major intraoperative problems include excessive trauma to tissues leading to large wall perforations, avulsions, or foreign body (e.g., stone) migration into the ureteral wall.

Table 2: Major complications (%)

Author	***Blute***	***Adlel-Razzak***	***Harmon***	***Grasso***
Year Published	1988	1992	1997	1998
Perforation	4.6	1.7	1	0
Stricture	1.4	0.7	0.5	0.5
Avulsion	0.6	0	0	0
Urinoma	0.6	---	0	0
Urosepsis	0.3	0	0	0
Cardiovascular accident	---	---	0.5	0.2

(27,28,29,30)

The major complication rate has decreased markedly and currently occurs in approximately 1% of all ureteroscopic procedures. As with the minor problems, major complications occur less frequently for basically the same reasons. However, when they do occur, treatment is often more complex.

In addition to major intraoperative problems, other complications that occur during upper urinary tract endoscopy may begin as minor events and, if left untreated or if addressed incorrectly, can progress to more serious conditions.

In a study by Yinghao et al, published in journal of endourology, 2000, 145 patients with ureteral calculi were treated with the Swiss Lithoclast. Ureteroscopic accessing of the stones was successful in 133 patients. In 27 patients, the stones were partially fragmented and remained in situ or were pushed back to the calices. They were subsequently treated successfully with SWL. Stones were fragmented in a single session in 101 cases. Complications associated with the procedure included five perforations and four urinary tract infections. Subsequently all of the five ureteral stone patients were treated successfully with pneumatic lithotripsy. The overall successful fragmentation rate thus was 70.7% (106 of 133) [31]

In a study by Terai A et al published in international journal of urology, 1996,a total of 51 patients with urinary calculi were treated with the Swiss Lithoclast; one patient with a renal calculus, 28 with ureteral calculi, and 22 with lower urinary tract (bladder, urethra and Kock pouch) calculi. The Lithoclast successfully fragmented 94% of the calculi, independent of stone composition. Complete failure of fragmentation was not encountered. In six of the 10 upper ureteral calculi, stone fragments were pushed up into the calyces. Adjunctive extracorporeal shock wave lithotripsy for residual fragments was performed in six cases. The stone-free rate at one and three months was 84% and 88%, respectively. There were no intraoperative or long-term complications [32]

In a study by Aquhamir et al, published in journal of endo urology in 2003, 340 patients (mean age 39.8 years; range 1.5-82 years) with a total of 362 ureteral calculi (bilateral in 22 cases) were treated with an 8.5F rigid ureteroscope and the Swiss Lithoclast. Of the calculi, 115 (32%) were located in the upper ureter, 63 (17%) in the middle ureter, and 184 (51%) in the lower ureter. The mean stone size was 10.4 mm (range 5-22 mm). Nearly all (344; 95%) of the calculi were accessible with the ureteroscope, and 321 calculi (88.7%) were fragmented completely, either with no residual fragments or with residual fragments <3 mm. In 3 cases (0.8%), there were residual fragments of about 4 mm after the procedure that passed spontaneously. Twenty calculi (5.5%) migrated to the kidney during the procedure and were subsequently treated with adjuvant SWL. Major complications occurred in 2 cases (0.54%): ureteral perforation and stenosis in 1 patient each. The 2-week stone-free rate was 89.5% (324/362). [33]

In a study by Hendrix et al published in 1999, 156 patients with extended-mid and distal ureteral stones were included. After randomization, 87 were treated with URS, and 69 with SWL. The treatment results were studied in relation to complications, the need for auxiliary procedures and stone factors, urinary tract infection (UTI), dilatation, and kidney function. After retreatment of 45% of the patients, the stone-free rate after 12 weeks in the SWL group was 51%. After a retreatment rate of 9% of the patients in the URS group, the stone-free rate was 91%. [34]

In a study by Yugisawa et al, in 2001, published in journal of urology, Twenty-two patients with ureteric calculi were treated using ureteroscopic pneumatic lithotripsy. Of the 22 stones, 8 (36%) were treated by ureteroscopic pneumatic lithotripsy as initial treatment and 14 (64%) with pneumatic lithotripsy as an auxiliary treatment after SWL. The stone sizes ranged from 7 to 16 mm with 14 located in the proximal, 3 in the middle, and 5 in the distal ureter. Twenty stones (91%) were effectively fragmented by ureteroscopic pneumatic lithotripsy and eliminated within 1 month after treatment. One stone could not be observed with the ureteroscope secondary to the kinking and stricture of the ureter under the stone, and the stone moved into the kidney during the procedure. The stone was subsequently treated successfully with SWL. One other stone was first fragmented into two pieces; and one big piece, which migrated into the kidney, was treated successfully with SWL. Complications such as bleeding, ureteral injury, and perforation did not occur. Although a few small fragments migrated into the kidney during the procedure in three cases, the overall stone-free rate at 1 month after a one-session treatment with pneumatic lithotripsy was 91%. [35]

In a study by Maheswari et al, published in journal of urology 1999, ureteroscopy was offered to 43 patients. Of these, retrograde ureteroscopy was done in 20 patients, while antegrade ureteroscopy was performed in 23 patients. All these patients were followed up to evaluate the immediate and long-term success of the procedure. The incidence and nature of complications were also noted. During retrograde ureteroscopy, complete stone clearance was achieved in 11 patients (55%), while pushback of the whole or fragmented calculus was seen in the rest. These patients with residual calculi were later treated by extracorporeal shockwave lithotripsy (SWL). The stone-free rate at the end of 3 months was 85%. Three patients developed minor ureteroscopy-related complications. Complete stone clearance was achieved in all patients with antegrade ureteroscopy. No intraoperative or postoperative complications were encountered. [36]

Tugh CV et al (2006) studied retrospectively, the medical records of 375 patients treated with URS-PL from January 1999 to September 2005 in their clinic. Of these patients, 213 were treated with URS-PL primarily (group 1), whereas the remaining 162 patients had undergone SWL unsuccessfully before URS-PL was performed (group 2). They used 9F or 9.5F rigid instruments and the Vibrolith (Elmed, Ankara, Turkey). In group 1, 206 patients (96.7%) were treated successfully with URS alone, as were 155 patients (95.6%) in group 2. Impacted stones were observed in 21 patients in group 1 (9.85%) and in 57 patients in group 2 (35.1%). The average operating time was 33.19 +/- 9.039 minutes in group 1 and 57.42 +/- 8.757 minutes in group 2. The stone-free rates of the two groups were significantly different on the first postoperative day, but this difference decreased to an insignificant level at the end of the first month. [37]

Morgentaler et al (1990) reviewed the management of 42 impacted ureteral calculi is reviewed. Impacted stones were defined by the inability to pass a guide wire or catheter on initial attempts. Stones were impacted in the upper ureter in 10 patients, mid ureter in 11 and lower ureter in 21. Upper ureteral stones were treated in 8 patients by extracorporeal shock wave lithotripsy after disimpaction by laser or other techniques. Mid ureteral stones were treated by laser alone in 7 patients and by extracorporeal shock wave lithotripsy after disimpaction in 4. Lower stones were treated by laser in 17 patients and ultrasound in 2. Complications included 3 major and 5 minor perforations, and 4 false passages. Treatment was successful without an open operation in 40 of 42 patients (95%). [24]

A Srivatsava studied 51 upper ureteric calculi treated with in situ extracorporeal shock wave lithotripsy (ESWL). Patients with mild proximal hydronephrosis (or none at all) had a success rate of 93% but only 35% of those in the impacted group (moderate to severe hydronephrosis) had a successful outcome. A percutaneous antegrade approach to 29 impacted upper ureteric calculi resulted in total clearance in 23 cases; 4 other patients were rendered stone-free following additional procedures, an overall success rate of 93%. The only complication was a ureteric stricture in 1 patient. [38]

In a study by Devarajan et al evaluating holmium YAG laser for impacted ureteric calculus, stones were completely cleared in 90% of the patients, with the best results in the lower and mid-ureter (97% and 96%, respectively) followed by the upper ureter (89%). Alternative procedures were required in only 17 (7%) patients; extracorporeal shock-wave lithotripsy in 13, percutaneous nephrolithotomy in two and open pyelolithotomy in two patients. Ureteric perforation occurred in 11 patients, including laparotomy for peritonitis in one, serious sepsis in two and strictures in 10 patients. Strictures were more common in association with impacted calculi in the upper ureter early in the series. In other study by Cheng et al, the postoperative stone-free rate was 100%. There were no intraoperative complications, even in the treatment for a 3.8-cm steinstrasse in the upper ureter. All preoperative hydronephrosis improved. In general, the operative time, not including anesthesia, was less than 30 minutes. There was no intraoperative or postoperative flank pain or fever when the procedure was combined with pressure irrigation for visual clearance and keeping the area stone-free.[39]

In a study by Deliveliotis C et al, 42 patients with impacted ureteral stones were evaluated and followed for two and a half years to check for long-term results. The calculi location included all three segments of the ureter (proximal, mid and distal). Patients' age ranged from 22 to 83 years (mean 52.5 years). Primarily, patients were manipulated with extracorporeal shock wave lithotripsy (ESWL) in situ, or following stenting. If the result was not satisfactory, then we proceeded to retrograde ureteroscopy and ureterolithotripsy. Open ureterolithotomy was our final choice. Thirty-six of the 42 patients (85.7%) were stone free without the need of an open procedure. Follow-up period ranged from 10 up to 40 months, with a median period of 30 months and was achieved in 30 patients (71.4%). Stone recurrence was noted in 4 cases, while hydronephrosis without evidence of stone presence in 2 patients.[40]

Roberts WW et al followed up the patients after ureteroscopy for development of stricture. Average duration of stone impaction before definitive treatment was 8.8 months (range 2 to 48) and mean stone size was 10.3 mm. (range 1 to 30). All stones were calcium based. There were 3 proximal, 8 mid and 10 distal ureteral calculi. At a mean follow-up of 7 months ureteral strictures developed in 5 patients (24%) at the previous stone site. Mean duration of stone impaction was 11 months (range 5 to 17) in patients with stricture versus 8.2 months (range 2 to 48) in those with no stricture. Four of the 5 strictures occurred in patients who had had iatrogenic ureteral perforation during previous unsuccessful attempts at stone removal. and found. [23]

Brito et al (2006), studied 42 patients with impacted ureteral stones who were treated by retrograde ureteroscopic pneumatic lithotripsy. Twenty-eight patients were female and 14 were male. The stone size ranged from 5 to 20 mm. The ureteral sites of the stones were distal in 21, middle in 12 and proximal in 9. Considering stones with distal location in the ureter, 1 patient had ureteral perforation and developed a stricture in the follow-up (4.7%). As for stones in the middle ureter, 2 perforations and 1 stricture were observed (8.3%) and regarding stones located in the proximal ureter, 5 perforations and 4 strictures occurred (44%). In the mid ureter, 1 ureteral avulsion was verified. In 34 patients without ureteral perforation, only 1 developed a stricture (2.9%). Of 8 patients who had perforation, 6 developed strictures. The overall incidence of stricture following treatment of impacted ureteral calculi was 14.2%. [41]

Gurbuz et al studied 160 patients with ureteric calculus. Seventy-four patients were treated with URS primarily (Group 1), while the remaining 86 patients received URS only after ESWL had failed (Group 2). For URS and lithotripsy, a 9.5 French rigid instrument and vibrolith (Elmed, Ankara, Turkey) were used. In Group 1, 73 of 74 patients (98.6%) were treated successfully by URS alone, as were 81 of 86 patients (94.4%) in Group 2. Impacted stones were also observed in 17 patients from Group 2. In these patients, endoscopic observation revealed edematous inflammation above and below the calculus. Ureteral perforation occurred in one patient from Group 2, which required surgical repair. There was no significant difference in the stone-free rates of the two groups $t = 1.4 < 1.96t(\text{infinity}, 0.05)$ [42]

With recent advances in endourology, the indications for open surgery have decreased considerably, from 26% in 1987-95 to 8% in 1996-98.

MATERIALS AND METHODS

All patients who came to the our outpatient department between November 2004 and January 2007 with history of loin pain and a diagnosis of ureteric calculus were evaluated for the study and taken up for ureteroscopy after obtaining informed consent. Patients in whom, the guide wire could not be negotiated beyond the calculus at initial attempts were included in the study.

Patients with retrocaval ureter, previous history of ureteric stricture, or obstructive megaureter, or diabetes and patients with recent evidence of urosepsis were excluded from the study.

Patients were analyzed with a devised proforma and the clinical findings and investigation findings were recorded.

Diagnosis of ureteric calculus was confirmed in all patients with USG, x ray KUB and IVP and patients were sub classified accordingly.

Ureteroscopy was done with a Wolf 8-9.8 Fr ureteroscope with a 250W Halogen light source, with a single chip video camera. Pneumatic lithoclast, with 1 mm probe was used for lithotripsy.

For those patients in whom ureteroscopy & lithotripsy was unsuccessful were subsequently managed with ESWL or Open ureterolithotomy.

5 F double J stent was kept as and when necessary, and it was removed at the end of 2 weeks after ensuring complete stone clearance.

TECHNIQUE

A plain x-ray film of the abdomen was obtained on the morning of the procedure to confirm presence and location of the ureteric calculus. We performed the procedure under spinal anaesthesia. The patient is placed in modified lithotomy position with hyper flexion of the contra lateral leg to facilitate the introduction and manipulation of the ureteroscope

Cystourethroscopy is performed to exclude concomitant disease using 21 Fr sheath / 30 deg scope. A 0.032 inch floppy tip guide-wire is introduced through the cystoscope and passed through the ureteric orifice, under fluoroscopic guidance. Initial attempt of passing guide wire past the calculus were unsuccessful in all cases.

We routinely dilated the ureteric orifice before URS using 5 Fr, 80cm long, 5mm x 4cm, balloon dilator. Balloon dilator passed over the previously placed guide wire.

After completion of dilatation, cystoscope is removed and the ureteroscope is introduced adjacent to the guide wire, into the ureter till the level of the stone. We use 8 – 9.8 Fr, semi rigid ureteroscope, with 6 Fr working channel (Richard Wolff). The lithoclast probe is introduced through the straight working channel, and brought in contact with the stone and it is fragmented into small pieces. As soon as stone gets disimpacted or stops fragmenting, we pushed our guide wire past the stone into the proximal ureter as a safety measure. We removed the larger fragments with a 3-pronged grasper or a Dormia basket and keep them in the bladder. Stone fragments smaller than 2 mm in size (less than twice the size of the guide wire) are left behind. We kept DJ stent only if the stone load was more than 1cm or if the procedure was traumatic.

Peri-operative antibiotic prophylaxis was given. Stone clearance and stent position was confirmed by x-ray KUB, on the next morning. Follow up is done at 2 weeks and if required at 4 weeks for stone free status.

PROFORMA

Name : Age / Sex : IP No.
Address: Date of admission: Date of surgery :
Date of discharge:

COMPLAINTS:

Pain Fever
Vomiting Hematuria
Calculuria LUTS
Co-morbidities
Smoking/ alcoholism
Previous Urinary tract surgeries

EXAMINATION :

Temp
Pulse Rate
BP
P/A:
External genitalia
P/R

INVESTIGATIONS :

Urine: Alb.
Sugar
Deposits
Urine: C/S.
Blood: Sugar: Urea:
Sr.Creatinine:
Electrolytes:
Hb%:
TLC:
X-ray KUB: (Rt.) (Lt.)
Site
Size
USG KUB: (Rt.) (Lt.)
HUN
Site
Size
IVU: Function
HUN
Site

PROCEDURE:

Anaesthesia:
Scope:
Meatal Dilatation:
Stone location:

Size :
ICL - Pneumatic:
Time:
Success:
Retrieval:

COMPLICATIONS:

Perforation:
Bleeding:
False Passage:
Stone migration:

STENTING:

FOLLOW UP: **2ND WEEK**

4TH WEEK

RESULTS

32 patients were included in the study

Table 1: Sex wise distribution of patients

Out of 32 patients 22 (68.75 %)were males and 10 (31.25 %) were females.

SEX	NUMBER	PERCENT
MALE	22	68.75
FEMALE	10	31.25
TOTAL	32	100

Table 2: Age wise distribution of patients

AGE (Yrs)	NUMBER	PERCENT
10-20	1	3.1
21-30	10	31
31-40	12	37.5
41-50	5	15.6
51-60	4	12.8
Total	32	100

The age range of the patients was between 17 and 54 years. The mean age was 34.56 years.
The largest age group of patients was between 20 – 40 yrs, with 10 in the range 20 – 30 and 12 in the range 31 – 40yrs.

Table 3: Symptom wise distribution of patients

SYMPTOMS	*NUMBER*	*PERCENT*
PAIN	32	100
HEMATURIA	3	9.3
CALCULURIA	1	3.1
LUTS	4	12.8

The most common symptom was pain in the loin , present in all 32 patients.
The next common symptom is LUTS, which is present in 12.8 % of patients.

Table 4: Location wise distribution of patients

LOCATION	*NUMBER*	*PERCENT*
UPPER 1/3	5	15.6
MIDDLE 1/3	13	40.6
LOWER 1/3	14	43.8
TOTAL	32	100

Most of the stones were located in the lower ureter, 14(43.8%). Least common in the upper ureter, 5(15.6%).

Table 5: Sidewise distribution of patients

SIDE	*NUMBER*	*PERCENT*
RIGHT	18	56.2
LEFT	14	43.8
TOTAL	32	100

18 (56.2%) patients had right ureteric calculus and the rest, left ureteric calculus.

Table 6: Size wise distribution of patients

SIZE (mm)	*NUMBER*	*PERCENT*
0-8	4	12.8
9-16	21	65.6
>16	7	21.6
TOTAL	32	100

Range: 6 – 21 mm **Mean**: 12.25 mm

The stone ranged in size from 6 to 21 mm, with most in the range of 9 –16mm. The mean stone size was 12.25 mm

Table 7: Success rate of ureteroscopy

SUCCESS	*NUMBER*	*PERCENT*
SUCCESSFUL	28	87.2
UNSUCCESSFUL	4	12.8
TOTAL	32	100

The success rate of ureteroscopy was 87.2%, (28/32)

Table 8: Difficulties encountered during ureteroscopy

REASON	*NUMBER*	*PERCENT*
MUCOSAL INJURY	1	3.1
BLEEDING / POOR VISION	2	6.3
FAILURE TO FRAGMENT	2	6.3
FRAGMENT MIGRATION	4	12.8

Stone migration was the most common complication noted during ureteroscopy. One patient developed flap elevation and bleeding in 2 patients and stone was resistant to fragmentation in 2 patients.

Table 9: Second procedures performed

SECOND PROCEDURE	*NUMBER*
REDO	3
ESWL	2
OPEN	2
TOTAL	7 (21.8 %)

7 patients had second procedure to completely clear the stone. Redo ureteroscopy was the second procedure commonly performed, in 3 patients. 2 patients with stone fragment migration were subjected to ESWL and 2 patients, who had failure of fragmentation of stone underwent open operation.

Table 10: Stent insertion

STENT	*NUMBER*	*PERCENT*
INSERTED	25	78.2
NOT INSERTED	7	21.8
TOTAL	32	100

Out of 32 patients ,DJ stent was inserted in 25 patients. In 7 patients stenting was not done.

Table 11: Complications

COMPLICATION	*NUMBER*	*PERCENT*
HEMATURIA	2	6.3
STONE MIGRATION	4	12.8
INFECTION	5	15.6

Infection was the most common complication noted postoperatively, in 5 patients. Stone migration was noted in 4 patients and bleeding in 2 patients. No perforation was noted in any patients.

Table 13: Success rate in relation to stone location

SITE	*NUMBER (OUT OF)*	*PERCENT*
UPPER 1/3	4 (5)	80
MIDDLE 1/3	11 (13)	84.6
LOWER 1/3	13 (14)	92.5

p - 0.69

The success rate in lower ureteric calculus is 92.5% (13/14). In upper ureteric calculus, the success rate is low at 80% (4/5).

Table 14: Success rate in relation to stone size

SIZE (mm)	*NUMBER*	*PERCENT*
0-8	4	100
9-16	19	90.47
>16	5	71.4

p - 0.028

The success rate in relation to stone size shows that stone less than 8 mm size was 100% successful and stones more than 16 mm size has a success rate of 71.4%. Stone size between 9 – 16 mm has a success rate of 90.47%.

Table 15: Time duration in relation to stone location

TIME DURATION	*MEAN (min)*	*RANGE (min)*
UPPER 1/3	87	60 –120
MIDDLE 1/3	79	40 –130
LOWER 1/3	50	25 – 110

p - 0.013

The tabulation of stone location in relation to duration of surgery shows that the mean duration was 87 min, 79 min, 50 min for the upper, middle and lower ureteric calculus respectively.

Table 16: Time duration in relation to stone size

TIME DURATION	***MEAN (min)***	***RANGE (min)***
0-8	50	25 –70
9-16	65	30 –120
>16	90	60 –130

P<0.001

The duration of surgery in relation to stone size shows that it is high 90 min, for stones >16mm and low, 50 min, for stones less than 8 mm.

Values of redo cases were excluded to avoid fallacious results.

Mean time duration: 69 min
Mean time duration in successful patients: 60 min
Mean time duration in unsuccessful patients: 120 min

Fig.1

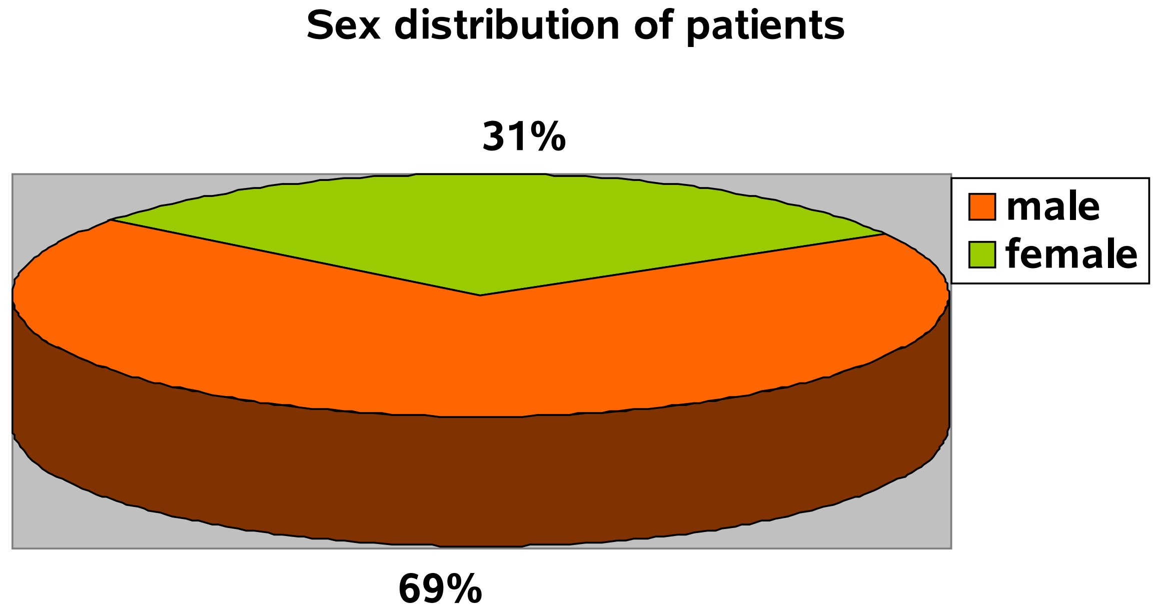

Sex distribution of patients
31%
male
female
69%

Fig.2

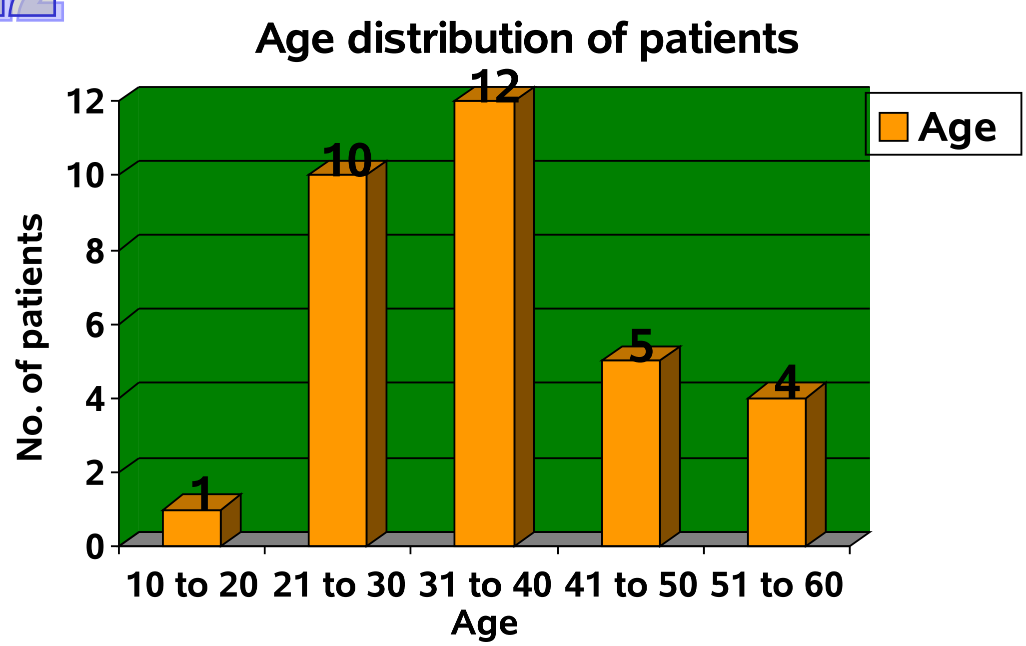

Age distribution of patients
12
10
8
6
4
2
0
No. of patients
1
10
12
5
4
Age
10 to 20
21 to 30
31 to 40
41 to 50
51 to 60
Age

Fig.3

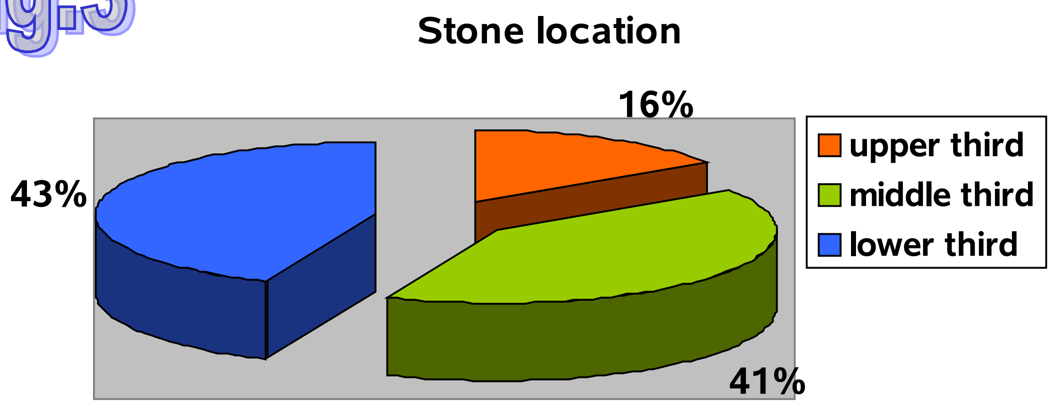


Fig.4

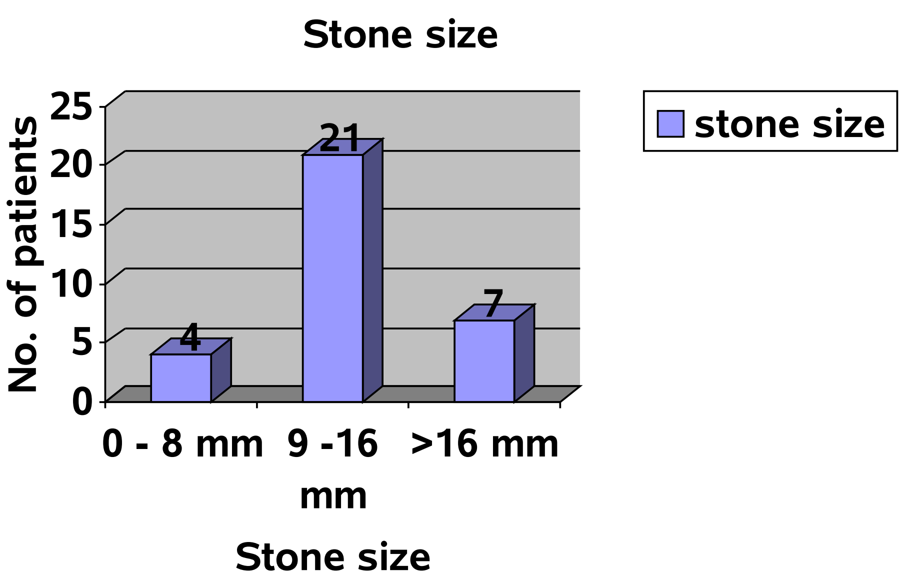


Fig.5

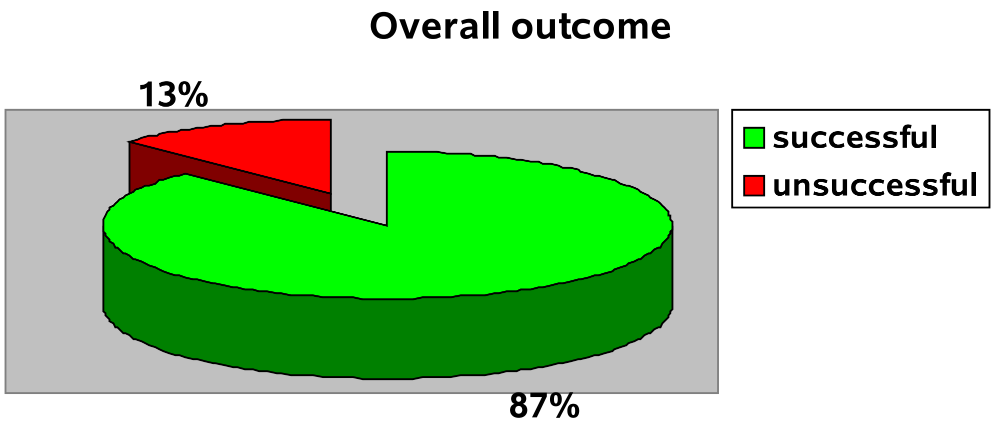

Overall outcome
13%
successful
unsuccessful
87%

Fig.6

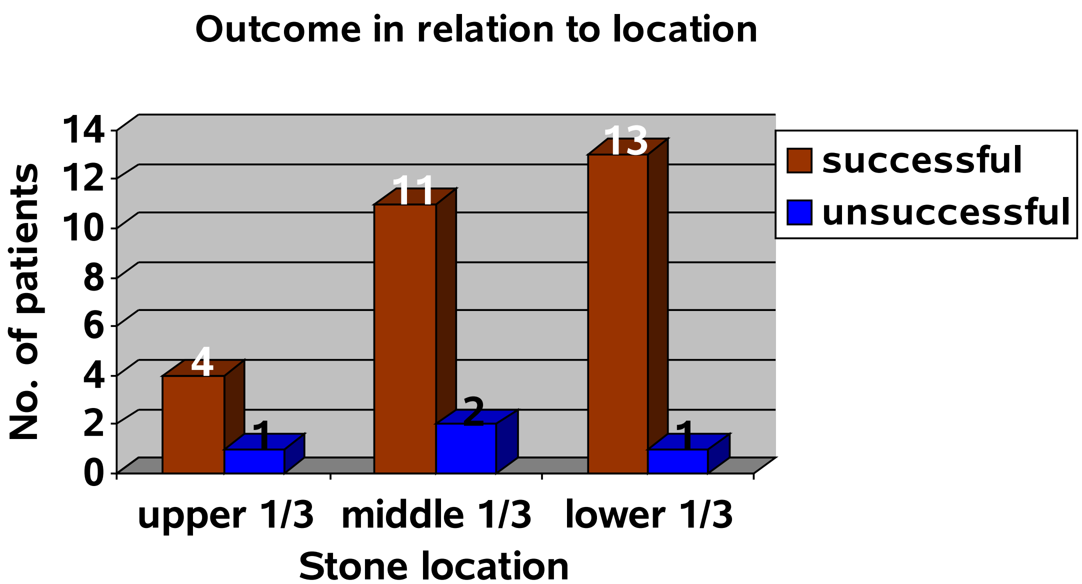
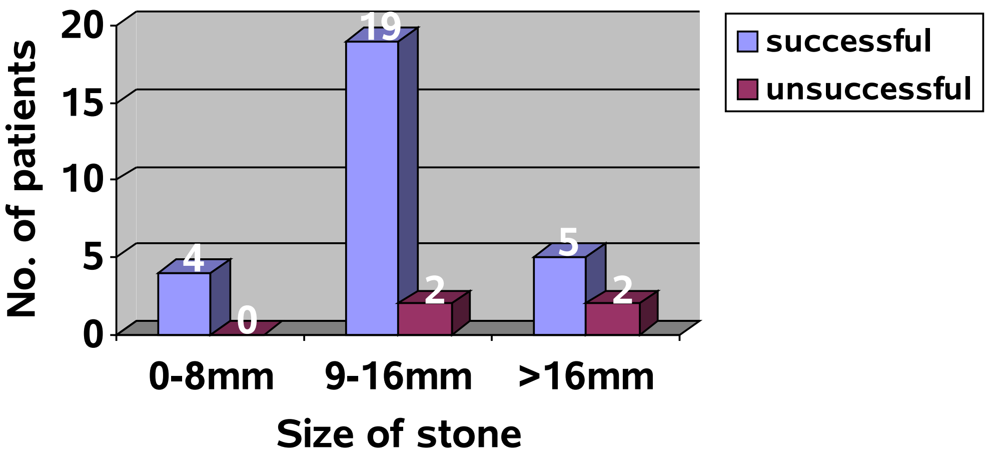

Outcome in relation to location
No. of patients
0
2
4
6
8
10
12
14
4
1
11
2
13
1
successful
unsuccessful
upper 1/3
middle 1/3
lower 1/3
Stone location

Fig.7

Outcome in relation to size



X ray KUB with right ureteric calculus

Fig.8

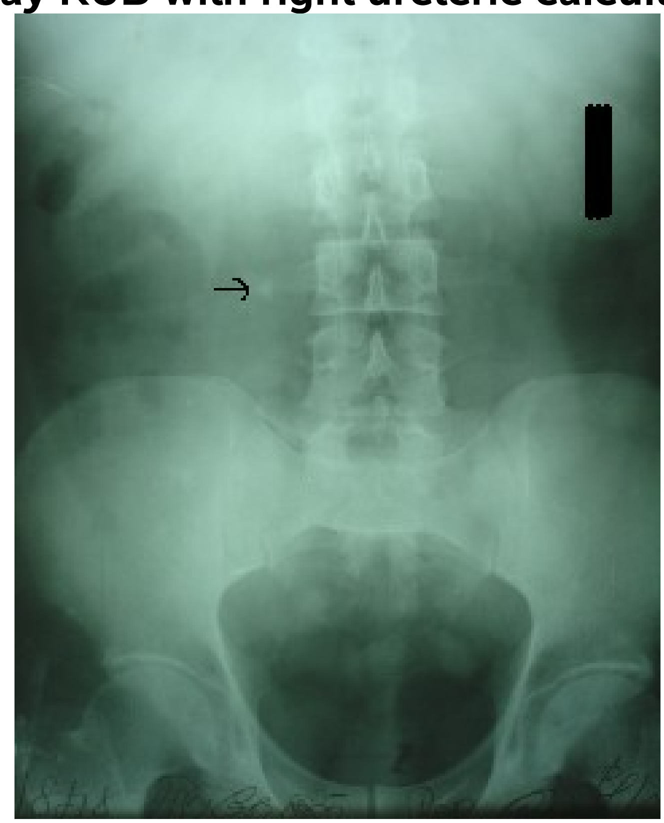


Fig.9

Intravenous urogram picture

X-ray with DJ stent in situ

Fig.10

DISCUSSION

Ureteral calculus is one of the common entities encountered by the practicing urologist. Though ureteric calculus is common, impacted ureteric calculus is less common, with various studies analyzing 30 –50 cases over a 3 – 5 year period. Management of impacted ureteric calculus continues to invoke much controversy, as many treatment options are available to the urologist. Each center presents data based on the equipment, technical expertise available and the patient load. There are several studies favoring ESWL or URS and more recently alternative modalities such as antegrade ureteroscopy and retroperitoneoscopy. All of them have their own advantages and disadvantages in different clinical situations.

An algorithm developed by Dretler in which lower ureteric calculi are treated with ureteroscopy, mid uretertic calculi by stent by pass and ESWL or by ureteroscopy, upper ureteral calculi by stent bypass and ESWL without manipulation and impacted ureteral stones initially by ureteroscopy and if necessary then by ESWL.

Robert Rheile et al have quoted that the best results are obtained by combination of ureteroscopy and ESWL, but not all centers can afford it. . In our study we had 32 patients with impacted ureteric calculus who were included in the study.

In our series out of 32 patients, 22 were male and 10 were female, the ratio was 2.2:1. This is similar to the sex ratio in most studies such as the one by Yogisawa et al.

The mean age group of the patients presenting to us with impacted ureteric calculus was 34.5yrs. Most of the patients (22/32) were in the age group 20 – 40 yrs which is commonly affected by the calculus disease.

The most common presenting symptom is pain, (100%) which correlates well with the available literature. Patients either had a constant dull aching or colicky pain. Out of 14 patients who had lower ureteric calculus, 4 had LUTS symptoms.

In most cases (86.5 %)the calculus were present in the mid and lower ureter which correlates with literature (Brito et al) that the site of impaction most commonly present in the distal ureter. The remaining 15% percent of patients had upper ureteric calculus.

In all the patients, the stones could be seen by URS once negotiation was successful. The stones were fragmented successfully in 28 patients. (including redo surgeries). In almost all cases only a small part of the stone surface was visible because of inflamed and edematous ureteral mucosa resulting from prolonged impaction of the calculus. We could manage fragmentation of these stones without any significant damage to ureteral mucosa. No perforation was seen in our study. Minimal bleeding from the impacted site was noted in 3 patients out of whom, in 2 patients, we could not proceed with URS due to poor visibility and the procedure was abandoned after DJ stenting and later taken up for redo procedure after 1 week.

Flap elevation occurred in one patient with lower ureteric calculus, during negotiation of ureteric orifice. So the procedure was abandoned after DJ stenting and redo procedure was taken up after 2 weeks

The success rate of ureteroscopy with intra corporeal lithotripsy in our study was 87.2%. (28 / 32). This includes 3 patients in whom lithotripsy was successful in the second attempt. The overall success rate in our study compares well with the available literature. Yogisawa et al had a success rate of 90% in his series of 22 patients treated with lithoclast. Morgentaler et al treated impacted ureteric calculus with ESWL, LASER and URS and had a success rate of around 95%.

Devarajan et al had a success rate of 90% with laser lithotripsy for impacted calculi. Deliveliotis had a success rate of 85.7% with ESWL for impacted calculus. Gurbuz et al showed a success rate of 95%

ICL was not successful in 2 patients. Both the patients had stones of size more than 18 mm, and were

managed with open surgeries. These stones were subsequently found to be composed of calcium oxalate monohydrate. Kirkali et al has quoted that open surgery is still one of the options in patients with impacted ureteric calculus, with failed URS, though retroperitoneoscopy may be preferred.
Stone migrated during ICL into the dilated upper tracts in 4 patients. Among them 2 were managed with URS itself. In 2 patients the stones migrated into the calyces and could not be managed with URS. So they were stented and advised to undergo ESWL. Maheswari et al had a stone migration rate of 45% and these were managed with ESWL.
5 patients had infection post operatively. 4 of them had prolonged procedures and one of them had flap elevation. All patients were treated with antibiotics according to sensitivity reports.
In our study, DJ stent was kept only if the stone burden was more than 1 cm, associated with complications, failed procedure or residual fragments. 7 patients were managed without stenting. Hosking and Smith clearly demonstrated that there was no need for routine insertion of DJ stent after URS.
We analysed the success rate of ICL with relation to stone size and location in ureter. The success rate was 80%, 84.6%, and 92.6% for upper, middle and lower ureteric calculi respectively. Chi square test was done to evaluate the significance of difference. The p value was 0.69. This showed that there was no statistically significant difference among the three location groups. In study by Devarajan et al the success rate was 89%, 96%, 97% for upper, middle and lower ureteric calculi respectively. This correlates well with our study results. Though there is less success rate with upper ureteric calculus, it is not statistically significant possibly due to small sample size.
Regarding success rate in relation to stone size, the average stone size in unsuccessful patients is 16.5mm and 11.79mm in successful patients. This was analysed by Student ‘t’ test and the p value was 0.028, which is statistically significant. This shows that as the stone size increases the success rate declines.
The time duration in relation to the location of stone in ureter is 87min, 79 min, and 50 min in upper, middle and lower ureteric calculi respectively. The p value by student ‘t’ test is 0.013, which is statistically significant. Duration in relation to stone size is also statistically significant with p value of 0.028. This shows that the duration of surgery is directly correlated with the stone size and location of calculus.
The incidence of complication has no relation with stone size, p vale 0.80. The duration of surgery has a possible statistically significant correlation with complication rate, with a p value of 0.083. The statistical significance of most values could not be relied upon in our study, may be because of small sample size.
Our study compares well with other world literature, which we reviewed. The overall success rate for URS in impacted ureteric calculus is 87.5%, which is acceptable with a complication rate of 25%. The success rate is higher for lower ureteric calculus and smaller stones. ESWL may be used as a primary modality of treatment or adjuvant therapy after unsuccessful URS for larger stones to improve success rate and reduce complications by reducing the duration of operation. Retroperitoneoscopic surgeries may be used in patients with failed ESWL and URS, with open surgery as a last resort.
Antegrade ureteroscopy with flexible ureteroscope is the state of the art treatment for impacted upper ureteric calculus now. PCNL has been used with high success rate in patients with failed other modalities, markedly dilated collecting systems, large stone burden and distal ureteric strictures.
In our study we were not able to include the later complications such as stricture formation, which has been documented in literature, due to practical difficulties in the patient follow up.

CONCLUSION

Ureteroscopy with pneumatic lithotripsy is efficacious in the management of impacted ureteric calculus.
Size and location of the stone are the factors, which influence the success of ureteroscopy.
Ureteroscopy is safe with minimal complications, in the management of impacted ureteric calculus.

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MAST
CHA

Age	Sex	I.P No.	Side	Ureter	Stone (mm)	Success	Stent	Time (
32	male	696150	right	upper	16	yes	yes	10
22	female	700301	right	middle	9	yes	no	60
31	female	700511	left	lower	9	yes	no	40
21	male	701185	right	middle	12	no	yes	12
54	male	705455	left	upper	7	yes	yes	60
24	female	700708	left	lower	10	yes	yes	45,3
34	male	708475	right	lower	13	yes	no	50
53	male	707161	right	middle	9	yes	yes	40
17	male	701888	right	middle	12	yes	no	60
35	female	713000	left	lower	11	yes	yes	55
23	male	714206	left	middle	20	no	yes	13
25	female	713541	left	middle	21	yes	yes	110,
24	female	714456	right	lower	12	yes	yes	60
42	male	719505	left	upper	10	yes	no	65
38	male	730530	left	lower	9	yes	yes	30
37	male	731956	right	middle	7	yes	yes	70
25	male	739953	right	lower	12	yes	yes	35
43	male	744280	left	middle	11	yes	no	65
33	male	763229	right	lower	10	yes	no	70
43	male	767087	left	middle	20	yes	yes	50
36	male	768995	left	lower	13	yes	yes	55
32	male	774201	right	upper	16	no	yes	12
44	male	781501	right	lower	14	yes	yes	80,4
28	male	788191	right	lower	10	yes	yes	30
28	male	791455	right	middle	14	yes	yes	11
48	male	798384	left	lower	6	yes	yes	25
31	female	856977	right	middle	12	yes	yes	10
52	female	855647	left	lower	8	yes	no	45
27	female	811730	right	middle	11	yes	yes	60
34	male	1737	left	middle	18	no	yes	11
38	female	867481	right	middle	18	yes	yes	90
52	male	4051	right	upper	10	yes	yes	30

unfrag -unfragmented

sm - stone fragment migration

hge - bleeding

inf- infection

open- open ureterolithotomy